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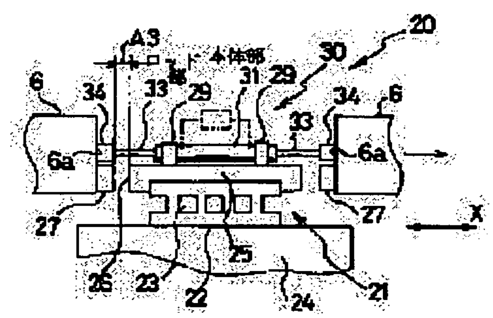
(54) VIBRATION DAMPING DEVICE FOR STRUCTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To damp the horizontal vibration ranging from small to large amplitude, which occurs in a structure to a base construction.

SOLUTION: A damping mechanism 20 of a vibration damping device is so constructed as to include a plastic deformation member 21 and an existing hydraulic damper 30. A main body 31 of the hydraulic damper 30 is secured to the plastic deformation member 21, which is then fastened to bridge piers, and rod sections 33 of the hydraulic damper 30 are connected to bridge girders to produce a structure which allows the plastic deformation member 21 to be deformed when the hydraulic damper 30 has made the specified stroke A3.



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CLAIMS

[Claim(s)]
[Claim 1] In the damping device of the structure which damps a horizontal vibration of the structure to the basic structured division It has the oleo damper which attenuates a horizontal vibration of said structure, and the plastic deformation member which attenuates a horizontal vibration of said structure through plastic deformation. The body section of said oleo damper is fixed to a plastic deformation member. The basic structured division and the structure, The damping device of the structure characterized by constituting so that a plastic deformation member may deform plastically, after it connects the rod section of an oleo damper with another side and an oleo damper operates by predetermined stroke, while fixing a plastic deformation member to one side.
[Claim 2] The damping device of the structure according to claim 1 characterized by preparing the quake-absorbing rubber bearing and/or skid bearing which control a horizontal vibration of the structure while supporting the structure in the direction of a vertical between said basic structured divisions and structures.
[Claim 3] The damping device of the structure according to claim 1 or 2 characterized by having a physical quantity detection means to detect the physical quantity relevant to the horizontal variation rate which acts on said structure, and the active control means to which the damping coefficient of an oleo damper is changed based on the amplitude for which it asked from the signal detected with this physical quantity detection means.
[Claim 4] Said active control means is the damping device of the structure according to claim 3 characterized by to control the damping coefficient of an oleo damper to enlarge the damping coefficient of an oleo damper in the state of a small amplitude which is generated in the vibration of those other than an earthquake, to set the damping coefficient of an oleo damper as the suitable value which demonstrates a damping function in the state of the amplitude below a predetermined value among amplitudes which are generated in the vibration in case of an earthquake, and to enlarge the damping coefficient of an oleo damper in the state of the amplitude beyond said predetermined value.
[Claim 5] The damping device of the structure given in any 1 term of claims 1-4 characterized by said structure being a bridge girder.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is equipped with the oleo damper which attenuates vibration especially, and a plastic deformation member about the damping device of the structure which damps a horizontal vibration of the structure to the basic structured division, and after an oleo damper operates by predetermined stroke, it relates to what was constituted so that a plastic deformation member might deform plastically.
[0002]
[Description of the Prior Art] Conventionally, practical use is presented with quake-absorbing rubber bearing, the plastic deformation member, the oleo damper, etc. as a damping device which damps a horizontal vibration of the structure to the basic structured division. It controls a horizontal vibration of the structure through the elastic deformation to the shear direction (horizontal) while quake-absorbing rubber bearing has the laminating rubber object which carried out the laminating of two or more steel plates and rubber plates by turns up and down, arranges it between the horizontal plane section of the basic structured division, and the horizontal plane section of the structure and supports vertical loads, such as dead weight of the structure, and a movable load, to the basic structured division.
[0003] Like said quake-absorbing rubber bearing, a plastic deformation member is arranged between the basic structured division and the structure, and attenuates a horizontal vibration of the structure to the basic structured division through the plastic deformation to the shear direction (horizontal). Although the plate member (honeycomb damper) of the shape of a blow hole of what was constituted from low yield point steel, and the bee in which two or more holes were formed etc. is conventionally known as a plastic deformation member, in consideration of the reinforcement of the structure etc., it is necessary to set the force by deformation of a plastic deformation member as a suitable value.
[0004] The piston by which the body section and the body circles with which oil pressure was generally filled up into the interior were inner-**(ed) as for the oleo damper, enabling free sliding, The rod section which is connected with a

piston and projects from the body section, one pair of oil sacs divided with the piston in body circles, It consists of orifices prepared in the oilway which connects one pair of oil sacs, and the oilway, while connecting the body section with one side of the basic structured division and the structure, the rod section is connected with another side, and a horizontal vibration of the structure to the basic structured division is attenuated. In this oleo damper, vibration of the inside amplitude can be covered from vibration of small-size width of face, and a horizontal vibration can be attenuated.
[0005] Moreover, the horizontal acceleration which acts on the structure is detected, and it asks for an amplitude, and has the active control means to which the damping coefficient of an oleo damper is changed based on the amplitude, and the damping device which may attenuate effectively a horizontal vibration of the structure to the basic structured division is also put in practical use.
[0006] Moreover, practical use is conventionally presented with the damping device equipped with said quake-absorbing rubber bearing, the damping device equipped with the plastic deformation member and quake-absorbing rubber bearing, and an oleo damper. What it is easy to deform by the small load to a plastic deformation member plastically is applied, and plastic deformation of the plastic deformation member is carried out with the elastic deformation of quake-absorbing rubber bearing, and while controlling vibration of the structure to the basic structured division, it can be made to decrease in the damping device equipped with quake-absorbing rubber bearing and a plastic deformation member (for example, quake-absorbing rubber bearing containing a lead plug). In the damping device equipped with quake-absorbing rubber bearing and an oleo damper, the operation which makes it decrease while controlling a horizontal vibration of the structure to the basic structured division is acquired, and the structure and an oleo damper can be restored to an initial valve position by quake-absorbing rubber bearing.
[0007]
[Problem(s) to be Solved by the Invention] However, in quake-absorbing rubber bearing, the depressant action of vibration has a possibility that quake-absorbing rubber bearing may fracture, when a massive earthquake occurs and the horizontal variation rate of the structure becomes large, since attenuation is low although it is. Moreover, although it is necessary to set up the horizontal rigidity of quake-absorbing rubber bearing low in order to raise the quake-absorbing engine performance, in connection with it, it becomes easy to generate vibration by horizontal loads, such as a wind load, and the usability of the structure may be degraded.
[0008] In order to enlarge attenuation by plastic deformation, it is necessary to enlarge rigidity of a plastic deformation member but, and in a plastic deformation member, since association with the structure and the basic structured division also serves as ** in connection with it, the seismic force transmitted from the basic structured division to the structure becomes large, and the quake-

absorbing engine performance falls. That is, attenuation and the quake-absorbing engine performance have the relation of a trade-off.

[0009] An oleo damper can cover vibration of the inside amplitude and it can be made to decrease it from vibration of small-size width of face. However, in the existing oleo damper, since it becomes stroke over and damages to vibration of the large amplitude generated according to a massive earthquake since the actuation stroke (about 40-50mm) is short, the vibration-deadening effectiveness is not expectable. Although it is not impossible to apply the large-sized oleo damper of a large stroke, either, the cost of a damping device becomes very expensive.

[0010] The purposes of this invention are offering the damping device which can cover vibration of the large amplitude from vibration of small-size width of face, and can damp a horizontal vibration of the structure to the basic structured division, offering the damping device which used the attenuation of an oleo damper effectively, offering the advantageous damping device in manufacture cost, etc.

[0011]

[Means for Solving the Problem] In the damping device of the structure with which the damping device of the structure of claim 1 damps a horizontal vibration of the structure to the basic structured division It has the oleo damper which attenuates a horizontal vibration of the structure, and the plastic deformation member which attenuates a horizontal vibration of the structure through plastic deformation. While fixing the body section of an oleo damper to a plastic deformation member and fixing a plastic deformation member to one side of the basic structured division and the structure, after it connects the rod section of an oleo damper with another side and an oleo damper operates by predetermined stroke, it constitutes so that a plastic deformation member may deform plastically.

[0012] While fixing the body section of an oleo damper to a plastic deformation member and fixing a plastic deformation member to one side of the basic structured division and the structure, the structure and the basic structured division are connected with another side through the oleo damper and the plastic deformation member by connecting the rod section of an oleo damper. When the structure vibrates horizontally to the basic structured division, first, an oleo damper operates and a horizontal vibration of the structure is attenuated. That is, vibrational energy can be absorbed and attenuated by the oleo damper without an oleo damper's carrying out plastic deformation of the plastic deformation member in vibration which does not operate beyond a predetermined stroke. If an oleo damper operates by predetermined stroke next, a plastic deformation member will deform plastically, vibrational energy will be absorbed, and a horizontal vibration of the structure will be attenuated.

[0013] That is, without raising the rigidity between the structure and the basic structured division, it is made to decrease effectively by the oleo damper, and is made to decrease through the plastic deformation of a plastic deformation

member to the vibration beyond a predetermined stroke from vibration of small-size width of face to the amplitude of a predetermined stroke. Although the rigidity of the connection section increases by the plastic deformation member, it can be set to the amplitude beyond a predetermined stroke. When rigidity changes with the amplitude, the seismic force which resonance with the structure and seismic force is prevented effectively, and acts on the structure becomes small. Therefore, in the damping device of this structure, it becomes possible to cover vibration of the large amplitude from vibration of small-size width of face, and to damp a horizontal vibration of the structure to the basic structured division. Moreover, since the existing oleo damper whose actuation stroke is not not much large can be used effectively, the damping device which employed the attenuation engine performance of an oleo damper efficiently is obtained, and it will become very [in manufacture cost] advantageous.
[0014] In invention of claim 1, between the basic structured division and the structure, the damping device of the structure of claim 2 prepares the quake-absorbing rubber bearing and/or skid bearing which control a horizontal vibration of the structure while supporting the structure in the direction of a vertical. That is, it becomes possible to attenuate further a horizontal vibration of the structure to the basic structured division. Moreover, it can respond to the thermal expansion and the heat shrink of the structure, and also vibration of the direction of a vertical of the structure can be controlled. And when preparing quake-absorbing rubber bearing, the restoration operation which restores the structure and an oleo damper to an initial valve position is acquired. In addition, the same operation as claim 1 is done so.
[0015] The damping device of the structure of claim 3 is equipped with a physical quantity detection means to detect the physical quantity relevant to the horizontal variation rate which acts on the structure, and the active control means to which the damping coefficient of an oleo damper is changed based on the amplitude for which it asked from the signal detected with this physical quantity detection means in claim 1 or invention of 2. That is, based on the amplitude of the structure, it becomes possible by changing the damping coefficient of an oleo damper to attenuate a horizontal vibration of the structure effectively by the oleo damper. In addition, claim 1 or the same operation as 2 is done so.
[0016] The damping device of the structure of claim 4 is set to invention of claim 3. An active control means The damping coefficient of an oleo damper is enlarged in the state of a small amplitude which is generated in the vibration of those other than an earthquake. In the state of the amplitude below a predetermined value, the damping coefficient of an oleo damper is set as the suitable value which demonstrates a damping function among amplitudes which are generated in the vibration in case of an earthquake. It is characterized by controlling the damping coefficient of an oleo damper to enlarge the damping coefficient of an oleo damper in the state of the amplitude beyond said predetermined value.

[0017] namely, in vibration of small amplitude which is generated in the vibration of those other than an earthquake By enlarging the damping coefficient of an oleo damper, an oleo damper is operated in stopper. Among amplitudes which it is made not to vibrate the structure to the basic structured division, and are generated in the vibration in case of an earthquake, in the state of the amplitude below a predetermined value By setting the damping coefficient of an oleo damper as a proper value, vibration of the structure is effectively attenuated by the oleo damper. In the state of the amplitude beyond a predetermined value, it becomes possible to operate an oleo damper in stopper and to promote the plastic deformation of a plastic deformation member by enlarging the damping coefficient of an oleo damper, among amplitudes which are generated in the vibration in case of an earthquake. After predetermined stroke actuation, vibration of the structure declines [an oleo damper] through the plastic deformation of a plastic deformation member. In addition, the same operation as claim 3 is done so.
[0018] The damping device of the structure of claim 5 is characterized by the structure being a bridge girder in invention given in any 1 term of claims 1-4. Therefore, even when vibration of the large amplitude can be covered very much from vibration of small-size width of face, a horizontal vibration of a bridge girder can be damped and a massive earthquake occurs especially, it becomes possible to avoid certainly the worst situation where a bridge girder falls from a bridge pier (or bridge abutment). In addition, the same operation as any 1 term of claims 1-4 is done so.
[0019]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. This operation gestalt is an example at the time of applying this invention to the damping device formed between the bridge piers (it is equivalent to the basic structured division) which support a bridge girder (it is equivalent to the structure), and a bridge girder in pons beam structure objects, such as a highway. However, horizontally a bridge axis direction is intersected perpendicularly with the direction of Y and a bridge axis direction is explained as a direction of X. As shown in drawing 1 and drawing 2 , the damping device 10 of the pons beam structure object 1 is formed between the edge of each bridge girder 2, and the bridge pier 8 in the bridge pier 8 which supports the edge of one pair of bridge girders 2, and the edge of these bridge girders 2.
[0020] The base structure 3 long and slender in the direction of Y in which each bridge girder 2 comes to cover [concrete] the top-face section of the basic frame which connected two or more steel materials, One pair of side-attachment-wall 5 grades which were connected with the inferior-surface-of-tongue section of the base structure 3, and were set up in the direction of Y to one pair of long and slender beam members 4 and the top-face both ends of the base structure 3 are constituted as a subject. To each bridge girder 2 The acceleration sensor 61 (physical quantity detection means) which detects the

acceleration of the direction of X, and the acceleration sensor 62 (physical quantity detection means) which detects the acceleration of the direction of Y are attached (refer to drawing 7). The edge of one pair of bridge girders 2 is connected by fork joint 2a which can respond to heat telescopic motion of a bridge girder 2. On the other hand in the bridge pier 8 which supports the edge of one pair of bridge girders 2, the back face 9 which has sufficient area to support the edge of one pair of bridge girders 2 in that top-face section is formed, and the damping device 10 is formed between this back face 9 and the beam member 4 of each bridge girder 2.

[0021] A damping device 10 is explained. As shown in drawing 1 and drawing 2 , while a damping device 10 supports vertical loads, such as dead weight of a bridge girder 2, and vehicle load It is prepared in the direction center section of X between one pair of quake-absorbing rubber bearing 12 which controls a horizontal vibration, and the edge of each bridge girder 2 and a bridge pier 8. The attenuation device 20 in which have the plastic deformation member 21 and an oleo damper 30, and vibration of the direction of X of the bridge girder 2 to a bridge pier 8 is attenuated, It is prepared in the direction both ends of X between the edge of each bridge girder 2, and a bridge pier 8, and has 2 sets of attenuation devices 40 in which have the plastic deformation member 41 and an oleo damper 50, respectively, and vibration of the direction of Y of the bridge girder 2 to a bridge pier 8 is attenuated.

[0022] One pair of quake-absorbing rubber bearing 12 is infixed, respectively between the lower limit side of one pair of beam members 4 of a bridge girder 2, and the back face 9 of a bridge pier 8, and the edge of a bridge girder 2 is supported by the bridge pier 8 through these quake-absorbing rubber bearing 12. As shown in drawing 3 , each quake-absorbing rubber bearing 12 The steel substrate 13 of one pair of upper and lower sides, The laminating rubber object 14 which carried out the laminating of two or more steel plates 15 prepared among one pair of steel substrates 13, and the hard-rubber plate 16 by turns, It consists of a steel substrate 13 and a lead plug 17 inserted in the vertical direction sense in the center section of the laminating rubber object 14, the upper steel substrate 13 is fixed to the beam member 4 of a bridge girder 2 with a bolt, and the lower steel substrate 13 is being fixed to the bridge pier 8 with the bolt. In addition, the steel plate for fixing the installation bases 24 and 42 of the quake-absorbing rubber bearing 12 and the attenuation devices 20 and 40 mentioned later is prepared in the top face of the bridge pier 8 made from a reinforced concrete.

[0023] The attenuation device 20 in which vibration of the direction of X of a bridge girder 2 is attenuated is explained. As shown in drawing 1 , drawing 4 - drawing 6 , the plastic deformation member 21 is what opened predetermined spacing in the direction of Y, and connected with it two or more plate members 22 (honeycomb damper) which formed two or more holes 23 in the direction of X, and is being fixed to the upper limit section of the installation base 24 fixed to the back face 9 of a bridge pier 8.

[0024] The damper receptacle member 25 for fixing an oleo damper 30 is connected with the upper limit part of the plastic deformation member 21 free [migration in the direction of Y]. One pair of auxiliary members 6 prolonged to a phase opposite side from one pair of beam members 4 (refer to drawing 1) of a bridge girder 2 attend the direction both sides of X of the damper receptacle member 25, respectively. If a bridge girder 2 carries out predetermined stroke A3 (for example, A3=30-40mm) migration from the initial valve position of drawing 4 in the direction of X to a bridge pier 8, as shown in drawing 5 When the edge 26 of the damper receptacle member 25 contacts and a bridge pier 2 moves in the direction of X further, as the load of the direction sense of X acts on the plastic deformation member 21 and it is shown in the shock absorbing rubber 27 which fixed to end-face 6a of the auxiliary member 6 at drawing 6 , the plastic deformation member 21 deforms plastically.
[0025] In an oleo damper 30, it has one pair of rod sections 33 prolonged out of the body section 31 and the both ends of the body section 31. The existing oleo damper with the actuation stroke a little longer than said predetermined stroke A3 is applied. The body section 31 is fixed to the damper receptacle member 25 with a bracket 29, and the point of one pair of rod sections 33 is connected with end-face 6a of one pair of said auxiliary members 6 fixed through the connection member 34. The damping coefficient alpha of an oleo damper 30 is controlled by the active control means mentioned later to be able to decrease effectively vibration of the direction of X of a bridge girder 2, without carrying out plastic deformation of the plastic deformation member 21, while an oleo damper 30 carries out predetermined stroke A3 actuation.
[0026] As shown in drawing 7 , inside the body section 31, a piston 32 is inner-**(ed) free [sliding], and said one pair of rod sections 33 were prolonged from this piston 32, and are projected to the exterior of the body section 31. The oil sacs 31a and 31b connected by the oilway 36 are formed in the part divided with the piston 32 of the body section 31 interior. The variable-aperture valve 35 of the electromagnetic-control type by which drive control is carried out with a control unit 60 is formed in an oilway 36, it asks for the amplitude A of the direction of X of a bridge girder 2 based on the acceleration of the direction of X which acts on the bridge girder 2 detected by the acceleration sensor 61 with the control unit 60, and the amount of drawing of the variable-aperture valve 35 of an electromagnetic-control type is controlled based on this amplitude A, and it constitutes so that the damping coefficient alpha of an oleo damper 30 may be changed. In addition, the variable-aperture valve 35 of a control unit 60 and an electromagnetic-control type is equivalent to an active control means.
[0027] By making the amplitude A of the direction of X of a bridge girder 2 into a parameter, active control of the damping coefficient alpha of an oleo damper 30 is carried out with the control unit 60 so that it may become the curve a of drawing 8 . When the amplitude A of a bridge girder 2 is 0, a damping coefficient alpha is set as alpha 1 [big]. When A is amplitudes0-A1, a damping coefficient alpha decreases-like proportionally [abbreviation] to the increment in an

amplitude A. When amplitudes A are A1-A2, a damping coefficient alpha is held at the suitable abbreviation constant value which demonstrates the attenuation engine performance, and a damping coefficient alpha increases it by-like proportionally [abbreviation] to the increment in an amplitude A at the time of AA2 or more (A3 is included) amplitudes. Here, they are A1=5mm, A2=20-30mm, and A3=30-40mm.

[0028] namely, in the state of the small amplitude A (A=0-A1) which is generated in the vibration of those other than an earthquake, said active control means By enlarging the damping coefficient alpha of an oleo damper 30, an oleo damper 30 is operated in stopper. Among the amplitudes A which are generated in the vibration in case of an earthquake, in the state of the amplitude A not more than predetermined value A2 (A=A1-A2) By setting the damping coefficient alpha of an oleo damper 30 as the suitable value which demonstrates a damping function Vibration of a bridge girder 2 is attenuated effectively, and an oleo damper 30 is operated in stopper, and it constitutes from enlarging the damping coefficient alpha of an oleo damper 30 in the state of the amplitude A beyond predetermined value A2 so that a vibrational load may be effectively transmitted to the plastic deformation member 21.

[0029] As shown in drawing 1 and drawing 2 , each of one pair of attenuation devices 40 which attenuates vibration of the direction of Y of a bridge girder 2 has the plastic deformation member 41 and the oleo damper 50. As shown in drawing 7 , an oleo damper 50 The body section 51, the rod section 53 of 52 or 1 pair of piston, oil sacs 51a and 51b, Have an oilway 56 and the variable-aperture valve 55 of an electromagnetic-control type, and the acceleration of the direction of Y which acts on a bridge girder 2 by the acceleration sensor 62 is detected. Based on the amplitude for which it asked from said acceleration with the control unit 60, the amount of drawing of the variable-aperture valve 55 of an electromagnetic-control type is controlled, and it constitutes so that it may be made to change in the property which shows the damping coefficient alpha of an oleo damper 50 in drawing 8 like the above. In addition, the variable-aperture valve 55 of a control unit 60 and an electromagnetic-control type is equivalent to an active control means.

[0030] In each attenuation device 40, the plastic deformation member 41 is fixed to the top face of the installation base 42, the damper receptacle member 45 is connected with the upper limit part of the plastic deformation member 41 free [migration in the direction of X], and the body section 51 of an oleo damper 50 is being fixed to this damper receptacle member 45. One pair of auxiliary members 7 are prolonged in the direction of X from the side-face subordinate edge of the beam member 4 of a bridge girder 2, and the point of the rod section 53 of an oleo damper 50 is connected with these one pairs of auxiliary members 7 fixed, respectively. In addition, since it is the same structure as said attenuation device 20, other explanation is omitted.

[0031] An operation and effectiveness of said damping device 10 are explained. In the state of the small amplitude A (A=0-A1) which is generated in vibration of

those other than an earthquake, such as everyday vibration at the time of car transit etc. The damping coefficient alpha of the oleo damper 30 controlled by the active control means Since it is large, 2 sets of oleo dampers 30 corresponding to the both ends of a bridge girder 2 can be operated in stopper, and a small vibration of the direction of X of a bridge girder 2 can be controlled according to the horizontal rigidity of the quake-absorbing rubber bearing 12 being weak.

[0032] Moreover, among the amplitudes A which are generated in the vibration in case of an earthquake, in the condition of the amplitude A not more than predetermined value A2 (A=A1-A2), the damping coefficient alpha of the oleo damper 30 controlled by the active control means can become the suitable value which demonstrates a damping function, and vibration of the direction of X of a bridge girder 2 can be effectively attenuated by the oleo damper 30 and the quake-absorbing rubber bearing 12, without carrying out plastic deformation of the plastic deformation member 21.

[0033] Among the amplitudes A which are generated in the vibration in case of an earthquake, in the condition of the amplitude A beyond predetermined value A2, the damping coefficient alpha of the oleo damper 30 controlled by the active control means can become large again, an oleo damper 30 can be operated in stopper, it can become possible to promote the plastic deformation of the plastic deformation member 21, and vibration of the direction of X of a bridge girder 2 can be attenuated through the plastic deformation of the plastic deformation member 21.

[0034] That is, since vibration from the vibration of small-size width of face to the predetermined stroke A2 can be attenuated by the oleo damper 30 and vibration of the large amplitude beyond predetermined stroke A2 can be attenuated through the plastic deformation of the plastic deformation member 21, it becomes possible to cover vibration of the large amplitude from vibration of small-size width of face, and to damp vibration of the direction of X of the bridge girder 2 to a bridge pier 8. So, since the existing oleo damper 30 whose actuation stroke is not not much large can be used effectively, taking advantage of the attenuation engine performance of an oleo damper 30, it will become very [in manufacture cost] advantageous.

[0035] Moreover, since the quake-absorbing rubber bearing 12 which controls a horizontal vibration of a bridge girder 2 was formed between the bridge pier 8 and the bridge girder 2, it can collaborate with an oleo damper 30 and the plastic deformation member 21, and vibration of the direction of X of the bridge girder 2 to a bridge pier 8 can be attenuated further. And by forming the quake-absorbing rubber bearing 12, the restoration operation which restores a bridge girder 2 and an oleo damper 30 to an initial valve position after vibration of the amplitude A not more than predetermined value A2 is acquired, it can respond to the thermal expansion and the heat shrink of a bridge girder 2, and also vibration of the direction of a vertical of a bridge girder 2 can be controlled.

[0036] Furthermore, the acceleration sensor 61 which detects the acceleration

of the direction of X which acts on a bridge girder 2, The active control means to which the damping coefficient alpha of an oleo damper 30 is changed based on the amplitude A of the direction of X of the bridge girder 2 for which it asked from the acceleration detected by this acceleration sensor 61 is established. By the active control means Since the damping coefficient alpha of the oleo damper 30 to the amplitude A of the direction of X is controlled to become the curve a of drawing 8 , it becomes possible to attenuate effectively vibration of the direction of X of a bridge girder 2.

[0037] In the state of the small amplitude A (A=0-A1) which is generated in the vibration of those other than an earthquake, specifically It is made not to vibrate a bridge girder 2 to a bridge pier 8 by enlarging the damping coefficient alpha of an oleo damper 30. Among the amplitudes A which are generated in the vibration in case of an earthquake, in the state of the amplitude A not more than predetermined value A2 (A=A1-A2) By setting the damping coefficient alpha of an oleo damper 30 as the suitable value which demonstrates a damping function Among the amplitudes A which are made to decrease vibration of a bridge girder 2 effectively, and are generated in the vibration in case of an earthquake, in the state of the amplitude A beyond predetermined value A2 By enlarging the damping coefficient alpha of an oleo damper 30, the plastic deformation of the plastic deformation member 21 is promoted, also by the collision of the damper receptacle member 25 and shock absorbing rubber 27, a buffer can be aimed at and bridge girder 2 vibration can be effectively attenuated through the plastic deformation of the plastic deformation member 21.

[0038] In addition, in case a bridge girder 2 vibrates in the direction of Y to a bridge pier 8, 4 sets of attenuation devices 40 corresponding to the both ends of a bridge girder 2 function as said attenuation device 20 similarly, and do so the operation and effectiveness which controls vibration of the direction of Y of a bridge girder 2 like the above. And like this operation gestalt, as a damping device which damps a horizontal vibration of the bridge girder 2 to a bridge pier 8, even when the damping device 10 which has the attenuation devices 20 and 40 was applied and a massive earthquake occurs, it becomes possible to avoid certainly the worst situation where a bridge girder 2 falls from a bridge pier 8 (or bridge abutment).

[0039] Next, the damping device of another operation gestalt is explained. the -- 1 another operation gestalt ... the [drawing 9 reference] -- damping device 10A of 1 another operation gestalt prepares attenuation device 40A instead of the attenuation device 40 in which vibration of the direction of Y of the bridge girder 2 to a bridge pier 8 is attenuated in said damping device 10. In attenuation device 40A, the plastic deformation member 70 is fixed to the inferior surface of tongue of the beam member 4 of a bridge girder 2, the damper receptacle member 71 is connected with the lower limit part of the plastic deformation member 70 movable only in the direction of X, and the body section 75 of an oleo damper 72 is being fixed to the inferior-surface-of-tongue section of the damper receptacle member 71 with the bracket 76.

[0040] An oleo damper [redacted] has the body section 75 an[redacted]he rod section 73 prolonged to a bridge pier 8 side, and the point of the rod section 73 is connected with side-face 8a of a bridge pier 8 fixed through the connection member 74. Moreover, shock-absorbing-rubber 27A which the edge of the damper receptacle member 71 contacts is attached in side-face 8a of a bridge pier 8. Attenuation device 40of this damping device 10A A does so the same operation and effectiveness as the attenuation device 40 of said operation gestalt.
[0041] the -- 2 another operation gestalt ... the [drawing 10 - drawing 12 reference] -- 2 another operation gestalt is an example at the time of applying this invention to the damping device which damps a horizontal vibration of the structures 84, such as a building to the basic structured division 82. In this damping device 10B, two or more quake-absorbing rubber bearing 12B, 2 sets of attenuation devices 80 which decrease vibration of the direction of X of the structure 84 to the basic structured division 82, and 2 sets of attenuation devices 81 which decrease vibration of the direction of Y of the structure 84 to the basic structured division 82 are established between the structure 84 and the basic structured division 82.
[0042] Since the attenuation devices 80 and 81 are the structures same only by the directions which decrease vibration of the structure 84 differing, they explain the attenuation device 80, and since they are the attenuation device 20 of said operation gestalt, and the same structure as abbreviation, give the same sign to the same thing as the attenuation device 20, and omit explanation. As shown in drawing 12 , in each attenuation device 80, in the lower limit section of the base member 83 of the structure 84, one pair of auxiliary members 85 have projected below, and the point of one pair of rod sections 33 of an oleo damper 30 is connected with these one pairs of auxiliary members 85 fixed, respectively. The plastic deformation member 21 is being fixed to the basic structured division 82.
[0043] Since according to damping device 10B vibration of the large amplitude is covered from vibration of small-size width of face, and it becomes possible to damp a horizontal vibration of the structure 84 to the basic structured division 82 and an actuation stroke can use effectively the existing oleo damper 30 which is not not much large, taking advantage of the attenuation engine performance of an oleo damper 30, it will become very [in manufacture cost] advantageous. In addition, the same operation and effectiveness as said Maine operation gestalt are done so.
[0044] the -- 3 another operation gestalt ... the [drawing 13 and / drawing 14 reference] -- damping device 10C of 3 another operation gestalt has a building 87 and two or more attenuation devices 90 arranged among 88, and damps a horizontal vibration of buildings 87 and 88. In each attenuation device 90, it attaches, and is fixed to the upper limit section of a member 89, and the plastic deformation member 91 is connected with the upper limit part of the plastic deformation member 91 free [migration to horizontally the direction which was

fixed to one building 87,[redacted]d where buildings 87 and 8[redacted]ounter, and the damper receptacle member 92 cross at right angles].

[0045] The body section 94 of an oleo damper 99 is fixed with a bracket 95 by the damper receptacle member 92, and the point of the rod section 96 of an oleo damper 99 is connected with the side face of the building 88 of another side fixed through the connection member 97. Moreover, the shock absorbing rubber 93 which the edge of the damper receptacle member 92 contacts is attached in the side face of the building 88 of said another side. In this damping device 10C, using a different amplitude produced to buildings 87 and 88, a horizontal vibration of buildings 87 and 88 is damped and the same operation and effectiveness as said operation gestalt are done so.

[0046] In addition, in said operation gestalt, and the 1st – the 3rd exception operation gestalt, various things, such as what was constituted for example, not only from what was indicated with said operation gestalt to the plastic deformation member but from low yield point steel, are applicable. Moreover, in an active control means, it is also possible to control the damping coefficient alpha of an oleo damper 30 so that it may become various properties, such as controlling the damping coefficient alpha of an oleo damper 30 to become the curve b of the chain line of drawing 8 .

[0047] Physical quantity detection sensors, such as a displacement sensor which can detect the rate sensor which can detect a horizontal rate instead of or a horizontal variation rate, may be formed, and based on the amplitude for which it asked from the signal detected by this physical quantity detection sensor, you may constitute so that the damping coefficient of an oleo damper may be changed. [acceleration sensors 61 and 62] Moreover, although not illustrated, in said operation gestalt and the 1st and 2nd exception operation gestalt, the skid bearing which attenuates vibration through friction with the basic structured division or the structure may be prepared instead of the quake-absorbing rubber bearing 12 and 12B, and this skid bearing may be prepared with the quake-absorbing rubber bearing 12 and 12B.

[0047]

[Effect of the Invention] According to the damping device of the structure of claim 1, when the structure vibrates horizontally to the basic structured division, first, an oleo damper operates and a horizontal vibration of the structure is attenuated. That is, if absorb vibrational energy by the oleo damper, and it is made to decrease and an oleo damper operates by predetermined stroke without an oleo damper's carrying out plastic deformation of the plastic deformation member in vibration which does not operate beyond a predetermined stroke next, a plastic deformation member will deform plastically, vibrational energy will be absorbed, and a horizontal vibration of the structure will be attenuated. That is, it becomes possible to cover vibration of the large amplitude from vibration of small-size width of face, and to damp a horizontal vibration of the structure to the basic structured division. So, since the existing oleo damper whose actuation stroke is not not much large can be used

effectively, the damping device which employed the attenuation engine performance of an oleo damper efficiently is obtained, and it will become very [in manufacture cost] advantageous.

[0048] Since according to the damping device of the structure of claim 2 the quake-absorbing rubber bearing and/or skid bearing which control a horizontal vibration of the structure were prepared between the basic structured division and the structure while supporting the structure in the direction of a vertical although the same effectiveness as claim 1 was done so, a horizontal vibration of the structure to the basic structured division can be attenuated further. Especially, in vibration of the small-size width of face of the structure, even if it does not operate an oleo damper, vibrational energy is absorbed by quake-absorbing rubber bearing, and it can control. Moreover, it can respond to the thermal expansion and the heat shrink of the structure, and also vibration of the direction of a vertical of the structure can be controlled. And when preparing quake-absorbing rubber bearing, the restoration operation which restores the structure and an oleo damper to an initial valve position is acquired.

[0049] According to the damping device of the structure of claim 3, do so claim 1 or the same effectiveness as 2, but Since it had a physical quantity detection means to detect the physical quantity relevant to the horizontal variation rate which acts on the structure, and the active control means to which the damping coefficient of an oleo damper is changed based on the amplitude for which it asked from the signal detected with this physical quantity detection means Based on the amplitude of the structure, an oleo damper enables it to attenuate a horizontal vibration of the structure effectively by changing the damping coefficient of an oleo damper.

[0050] According to the damping device of the structure of claim 4, do so the same effectiveness as claim 3, but In vibration of small amplitude which is generated in the vibration of those other than an earthquake By enlarging the damping coefficient of an oleo damper, an oleo damper is operated in stopper. Among amplitudes which it is made not to vibrate the structure to the basic structured division, and are generated in the vibration in case of an earthquake, in the state of the amplitude below a predetermined value By setting the damping coefficient of an oleo damper as a proper value, vibration of the structure is effectively attenuated by the oleo damper. In the state of the amplitude beyond a predetermined value, it becomes possible to operate an oleo damper in stopper and to promote the plastic deformation of a plastic deformation member by enlarging the damping coefficient of an oleo damper, among amplitudes which are generated in the vibration in case of an earthquake. An oleo damper can attenuate vibration of the structure through the plastic deformation of a plastic deformation member after predetermined stroke actuation.

[0051] Even when according to the damping device of the structure of claim 5 vibration of the large amplitude can be covered very much from vibration of small-size width of face, a horizontal vibration of a bridge girder can be damped

and a massive earthqua[illegible] occurs especially since the[illegible]ructure is a bridge girder although the same effectiveness as any 1 term of claims 1-4 is done so, it becomes possible to avoid certainly the worst situation where a bridge girder falls from a bridge pier (or bridge abutment).

[Translation done.]

* NOTICES *

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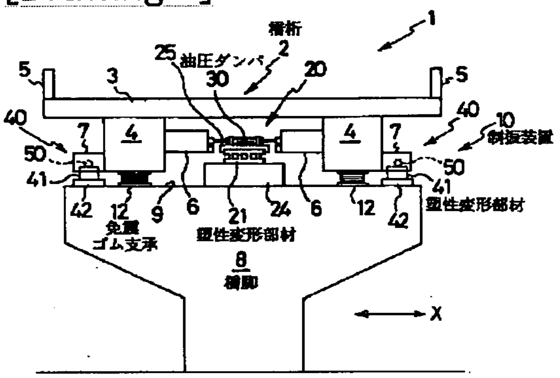
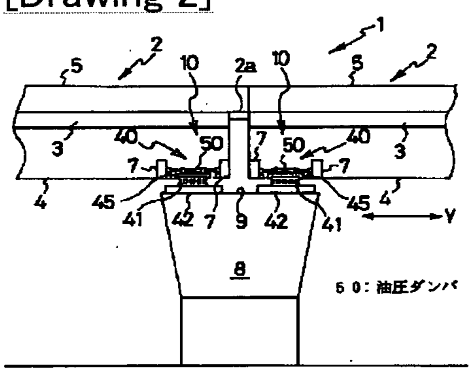
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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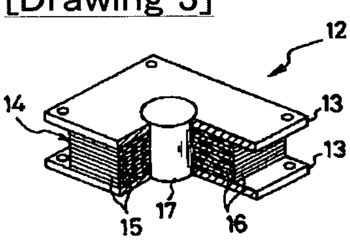

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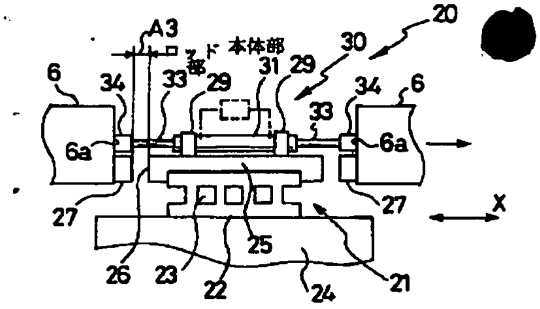

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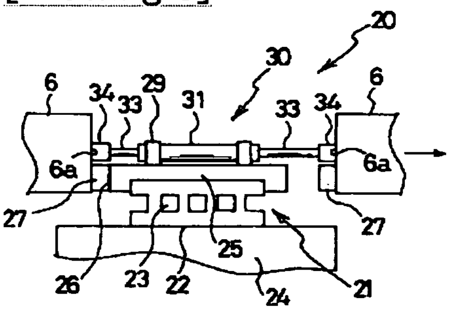

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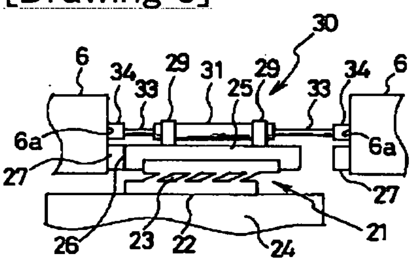

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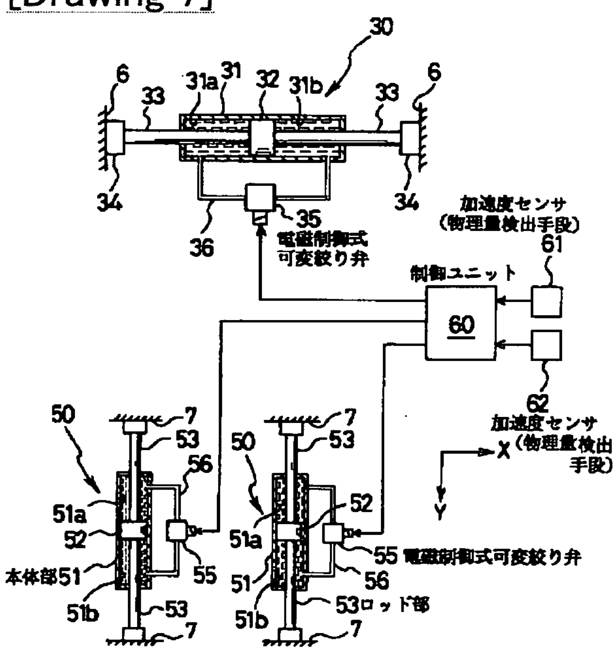

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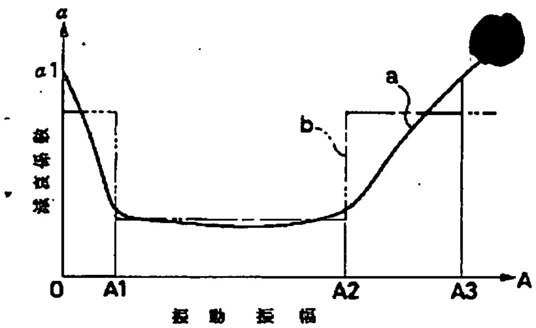
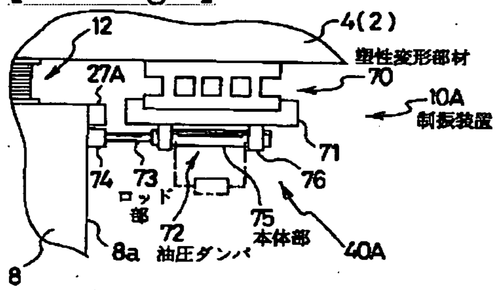
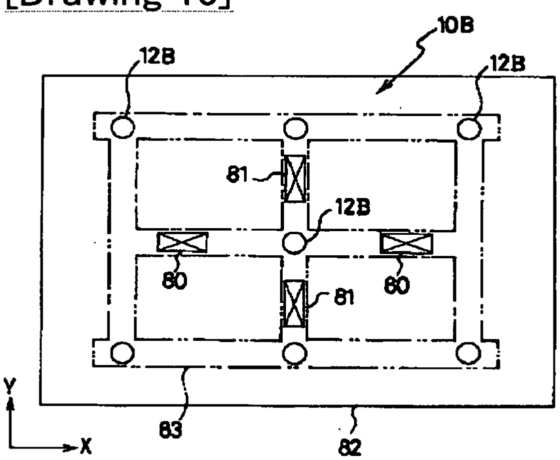


[Drawing 9]



[Drawing 10]



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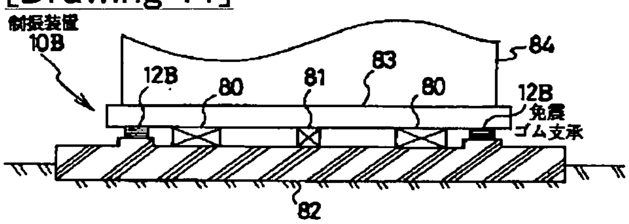
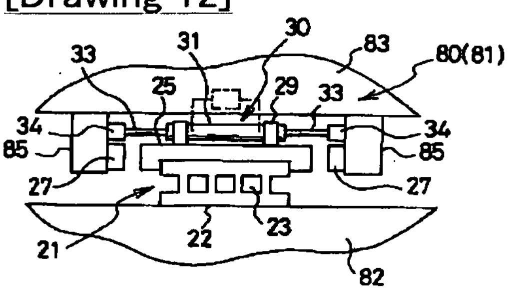
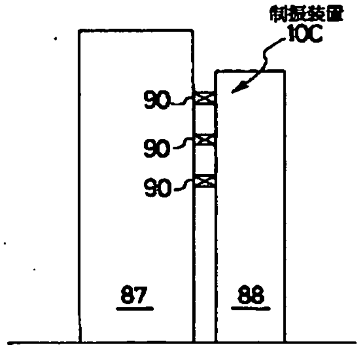


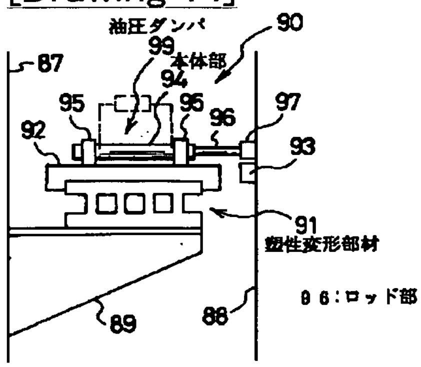
[Drawing 12]



[Drawing 13]



[Drawing 14]



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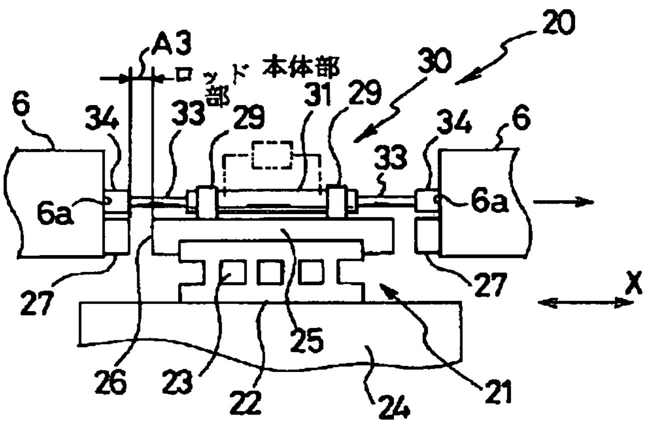
Drawing selection Representative drawing



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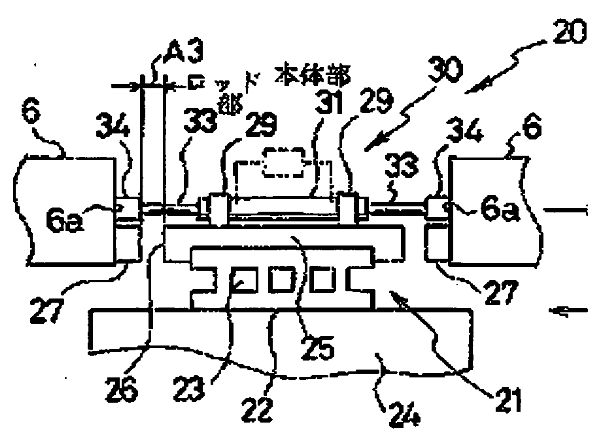
最終頁に

(54)【発明の名称】　構造物の制振装置

(57)【要約】
【課題】　従来、既存の油圧ダンパを備えた構造物の制振装置では、油圧ダンパの作動ストローク（約４０～５０mm）が短い関係上、大型の地震に対応できず、大ストロークの大型の油圧ダンパを適用しなければならないため、制振装置のコストが非常に高価になる。
【解決手段】　制振装置１０の減衰機構２０は、塑性変形部材２１と既存の油圧ダンパ３０を有し、油圧ダンパ３０の本体部３１を塑性変形部材２１に固定し、橋脚８に塑性変形部材２１を固定するとともに、橋桁２に油圧ダンパ３０のロッド部３３を連結し、油圧ダンパ３０が所定ストロークＡ３分作動してから塑性変形部材２１が塑性変形するように構成した。



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【特許請求の範囲】

【請求項１】　基礎構造部に対する構造物の水平方向の振動を制振する構造物の制振装置において、

前記構造物の水平方向の振動を減衰させる油圧ダンパと、

前記構造物の水平方向の振動を塑性変形を介して減衰させる塑性変形部材とを備え、

前記油圧ダンパの本体部を塑性変形部材に固定し、基礎構造部と構造物の、一方に塑性変形部材を固定するとともに他方に油圧ダンパのロッド部を連結し、油圧ダンパが所定ストローク分作動してから塑性変形部材が塑性変形するように構成したことを特徴とする構造物の制振装置。

【請求項２】　前記基礎構造部と構造物の間に、構造物を鉛直方向に支持するとともに構造物の水平方向の振動を抑制する免震ゴム支承及び／又はすべり支承を設けたことを特徴とする請求項１に記載の構造物の制振装置。

【請求項３】　前記構造物に作用する水平方向の変位に関連する物理量を検出する物理量検出手段と、この物理量検出手段で検出された信号から求めた振動振幅に基づいて油圧ダンパの減衰係数を変化させるアクティブ制御手段とを備えたことを特徴とする請求項１又は２に記載の構造物の制振装置。

【請求項４】　前記アクティブ制御手段は、地震以外の振動で発生するような小さな振動振幅の状態では油圧ダンパの減衰係数を大きくし、地震時の振動で発生するような振動振幅のうち所定値以下の振動振幅の状態では油圧ダンパの減衰係数を減衰機能を発揮する適切な値に設定し、前記所定値以上の振動振幅の状態では油圧ダンパの減衰係数を大きくするように油圧ダンパの減衰係数を制御することを特徴とする請求項３に記載の構造物の制振装置。

【請求項５】　前記構造物が橋桁であることを特徴とする請求項１～４の何れか１項に記載の構造物の制振装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、基礎構造部に対する構造物の水平方向の振動を制振する構造物の制振装置に関し、特に、振動を減衰させる油圧ダンパと塑性変形部材を備え、油圧ダンパが所定ストローク分作動してから塑性変形部材が塑性変形するように構成したものに関する。

【０００２】

【従来の技術】従来、基礎構造部に対する構造物の水平方向の振動を制振する制振装置として、免震ゴム支承、塑性変形部材、油圧ダンパ等が実用に供されている。免震ゴム支承は、複数の鋼板とゴム板とを上下に交互に積

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の死荷重や積載荷重等の鉛直荷重を支持するとと構造物の水平方向の振動を剪断方向（水平方向）性変形を介して抑制する。

【０００３】塑性変形部材は、前記免震ゴム支承に、基礎構造部と構造物間に配設され、基礎構造する構造物の水平方向の振動を、剪断方向（水平への塑性変形を介して減衰させる。従来、塑性変としては、低降伏点鋼で構成したものや、複数の成した蜂の巣状のプレート部材（ハニカムダンパ知られているが、構造物の強度等を考慮して、塑部材の変形荷重を適切な値に設定する必要がある

【０００４】油圧ダンパは、一般に、内部に油圧された本体部、本体部内に摺動自在に内嵌されたン、ピストンに連結され本体部から突出するロッ本体部内においてピストンにより仕切られた１対室、１対の油室を接続する油路、油路に設けられフィス等で構成され、基礎構造部と構造物の、一体部を連結するとともに他方にロッド部を連結し構造部に対する構造物の水平方向の振動を減衰さこの油圧ダンパにおいては、小振幅の振動から中振動に亙って水平方向の振動を減衰させることがる。

【０００５】また、構造物に作用する水平方向のを検出して振動振幅を求め、その振動振幅に基づ圧ダンパの減衰係数を変化させるアクティブ制御備え、基礎構造部に対する構造物の水平方向の振果的に減衰させ得る制振装置も実用化されている

【０００６】また、従来、前記免震ゴム支承と塑部材を備えた制振装置や、免震ゴム支承と油圧ダ備えた制振装置は実用に供されている。免震ゴム塑性変形部材を備えた制振装置においては、塑性材に小さな荷重で塑性変形し易いものを適用し、ム支承の弾性変形とともに塑性変形部材を塑性変せ、基礎構造部に対する構造物の振動を抑制するに減衰させることができる（例えば、鉛プラグ入震ゴム支承）。免震ゴム支承と油圧ダンパを備え装置においては、基礎構造部に対する構造物の水の振動を抑制するとともに減衰させる作用が得らた。免震ゴム支承により、構造物と油圧ダンパを置へ復元させることができる。

【０００７】

【発明が解決しようとする課題】しかし、免震ゴにおいては、振動の抑制作用はあるが減衰作用がめ、大型の地震が発生して、構造物の水平方向の大きくなると、免震ゴム支承が破断する虞があるた、免震性能を高める為には、免震ゴム支承の水の剛性を低く設定する必要があるが、それにとも風荷重等の水平荷重による振動が発生し易くなり

衰作用を大きくするには、塑性変形部材の剛性を大きくする必要があるが、それに伴って構造物と基礎構造部との結合も剛となるため、基礎構造部から構造物に伝わる地震力は大きくなり免震性能は低下する。つまり、減衰作用と免震性能はトレードオフの関係にある。

【0009】油圧ダンパは、小振幅の振動から中振幅の振動に亘って減衰させることができる。しかし、既存の油圧ダンパでは、作動ストローク（約40～50mm）が短いため、大型地震により発生する大振幅の振動に対してはストロークオーバーとなり破損するため制振効果を期待できない。大ストロークの大型の油圧ダンパを適用することも不可能ではないが、制振装置のコストが非常に高価になる。

【0010】本発明の目的は、小振幅の振動から大振幅の振動に亘って基礎構造部に対する構造物の水平方向の振動を制振可能な制振装置を提供すること、油圧ダンパの減衰作用を有効活用した制振装置を提供すること、製作コスト的に有利な制振装置を提供すること、等である。

【0011】

【課題を解決するための手段】請求項1の構造物の制振装置は、基礎構造部に対する構造物の水平方向の振動を制振する構造物の制振装置において、構造物の水平方向の振動を減衰させる油圧ダンパと、構造物の水平方向の振動を塑性変形を介して減衰させる塑性変形部材とを備え、油圧ダンパの本体部を塑性変形部材に固定し、基礎構造部と構造物の、一方に塑性変形部材を固定するとともに他方に油圧ダンパのロッド部を連結し、油圧ダンパが所定ストローク分作動してから塑性変形部材が塑性変形するように構成したものである。

【0012】油圧ダンパの本体部を塑性変形部材に固定し、基礎構造部と構造物の、一方に塑性変形部材を固定するとともに他方に油圧ダンパのロッド部を連結することで、構造物と基礎構造部とは油圧ダンパと塑性変形部材を介して連結されている。構造物が基礎構造部に対して水平方向へ振動した場合、先ず、油圧ダンパが作動して構造物の水平方向の振動を減衰させる。即ち、油圧ダンパが所定ストローク以上作動しない振動においては、塑性変形部材を塑性変形させないで、油圧ダンパにより、振動エネルギーを吸収して減衰させることができる。油圧ダンパが所定ストローク分作動すると、次に、塑性変形部材が塑性変形して、振動エネルギーを吸収し構造物の水平方向の振動を減衰させる。

【0013】即ち、小振幅の振動から所定ストロークの振幅まで、構造物と基礎構造部の間の剛性を高めることなく、油圧ダンパにより効果的に減衰させ、所定ストローク以上の振動に対しては塑性変形部材の塑性変形を介して減衰させる。塑性変形部材により連結部の剛性は高

地震力との共振は効果的に防止され構造物に作用
震力は小さくなる。従って、この構造物の制振装
いては、小振幅の振動から大振幅の振動に亘って
構造部に対する構造物の水平方向の振動を制振す
が可能になる。また、作動ストロークが余り大き
既存の油圧ダンパを有効活用できるため、油圧ダ
減衰性能を生かした制振装置が得られ、また、製
ト的に非常に有利なものになる。

【0014】請求項2の構造物の制振装置は、請
の発明において、基礎構造部と構造物の間に、構
鉛直方向に支持するとともに構造物の水平方向の
抑制する免震ゴム支承及び／又はすべり支承を設
のである。即ち、基礎構造部に対する構造物の水
の振動を一層減衰させることが可能になる。また
物の熱膨張や熱収縮に対応できる他、構造物の鉛
の振動も抑制することができる。しかも、免震ゴ
を設ける場合には、構造物と油圧ダンパを初期位
元させる復元作用が得られる。その他請求項1と
作用を奏する。

【0015】請求項3の構造物の制振装置は、請
又は2の発明において、構造物に作用する水平方
位に関連する物理量を検出する物理量検出手段と
物理量検出手段で検出された信号から求めた振
基づいて油圧ダンパの減衰係数を変化させるアク
制御手段とを備えたものである。即ち、構造物の
幅に基づいて、油圧ダンパの減衰係数を変化させ
で、油圧ダンパにより構造物の水平方向の振動を
に減衰させることが可能になる。その他請求項1
と同様の作用を奏する。

【0016】請求項4の構造物の制振装置は、請
の発明において、アクティブ制御手段は、地震以
動で発生するような小さな振動振幅の状態では油
パの減衰係数を大きくし、地震時の振動で発生す
な振動振幅のうち所定値以下の振動振幅の状態で
ダンパの減衰係数を減衰機能を発揮する適切な値
し、前記所定値以上の振動振幅の状態では油圧ダ
減衰係数を大きくするように油圧ダンパの減衰係
御することを特徴とするものである。

【0017】即ち、地震以外の振動で発生するよ
さな振幅の振動では、油圧ダンパの減衰係数を大
ることで、油圧ダンパをストッパ的に機能させて
物を基礎構造部に対して振動させないようにし、
の振動で発生するような振動振幅のうち所定値以
動振幅の状態では、油圧ダンパの減衰係数を適正
設定することで、油圧ダンパにより構造物の振
的に減衰させ、地震時の振動で発生するような振
のうち所定値以上の振動振幅の状態では、油圧ダ
減衰係数を大きくすることで、油圧ダンパをスト

は、塑性変形部材の塑性変形を介して構造物の振動が減衰される。その他請求項3と同様の作用を奏する。

【0018】請求項5の構造物の制振装置は、請求項1～4の何れか1項に記載の発明において、構造物が橋桁であることを特徴とするものである。故に、小振幅の振動から非常に大振幅の振動に亙って橋桁の水平方向の振動を制振することができ、特に、大型地震が発生した場合でも、橋桁が橋脚（又は橋台）から落下するという最悪の事態を確実に回避することが可能になる。その他請求項1～4の何れか1項と同様の作用を奏する。

【0019】

【発明の実施の形態】以下、本発明の実施の形態について、図面を参照して説明する。本実施形態は、高速道路等の橋梁構造物において、橋桁（構造物に相当する）と橋桁を支持する橋脚（基礎構造部に相当する）間に設けられる制振装置に、本発明を適用した場合の例である。但し、橋軸方向をY方向、橋軸方向と直交する水平方向をX方向として説明する。図1、図2に示すように、橋梁構造物1の制振装置10は、1対の橋桁2の端部とそれら橋桁2の端部を支持する橋脚8において、各橋桁2の端部と橋脚8との間に設けられている。

【0020】各橋桁2は、複数の鋼材を連結した基礎フレームの上面部に、コンクリートを敷きつめてなるY方向に細長いベース構造体3と、ベース構造体3の下面部に連結されY方向に細長い1対の梁部材4と、ベース構造体3の上面両端部に立設された1対の側壁5等を主体として構成され、各橋桁2には、X方向の加速度を検知する加速度センサ61（物理量検出手段）と、Y方向の加速度を検知する加速度センサ62（物理量検出手段）が取付けられている（図7参照）。1対の橋桁2の端部は、橋桁2の熱伸縮に対応可能なフォークジョイント2aで連結されている。一方、1対の橋桁2の端部を支持する橋脚8においては、その上面部に1対の橋桁2の端部を支持するのに十分な面積を有する支持面9が形成され、この支持面9と各橋桁2の梁部材4との間に制振装置10が設けられている。

【0021】制振装置10について説明する。図1、図2に示すように、制振装置10は、橋桁2の死荷重や車両荷重等の鉛直荷重を支持するとともに、水平方向の振動を抑制する1対の免震ゴム支承12と、各橋桁2の端部と橋脚8との間のX方向中央部に設けられ、塑性変形部材21と油圧ダンパ30を有し橋脚8に対する橋桁2のX方向の振動を減衰させる減衰機構20と、各橋桁2の端部と橋脚8との間のX方向両端部に設けられ、塑性変形部材41と油圧ダンパ50を夫々有し橋脚8に対する橋桁2のY方向の振動を減衰させる2組の減衰機構40を有している。

【0022】1対の免震ゴム支承12は、橋桁2の1対が橋脚8に支持されている。図3に示すように、ゴム支承12は、上下1対の鋼製基板13と、1製基板13間に設けられた複数の鋼板15と硬質16とを交互に積層した積層ゴム体14と、鋼製3と積層ゴム体14の中央部に上下方向向きに挿た鉛プラグ17とで構成され、上側の鋼製基板1桁2の梁部材4にボルトで固定され、下側の鋼製3が橋脚8にボルトで固定されている。尚、鉄筋リート製の橋脚8の上面には、免震ゴム支承12する減衰機構20，40の載置台24、42を固為の鋼板が設けられている。

【0023】橋桁2のX方向の振動を減衰させる構20について説明する。図1、図4～図6に示に、塑性変形部材21は、孔23をX方向に複数たプレート部材22（ハニカムダンパ）を、Y方定間隔をあけて複数枚連結したもので、橋脚8の9に固定された載置台24の上端部に固定されて

【0024】塑性変形部材21の上端部分には、ンパ30を固定する為のダンパ受け部材25が、に移動自在に連結されている。ダンパ受け部材2方向両側には、橋桁2の1対の梁部材4（図1参ら相対向側へ延びる1対の補助部材6が夫々臨みの初期位置から橋桁2が橋脚8に対してX方向へトロークA3（例えば、A3＝30～40mm）移と、図5に示すように、補助部材6の端面6aにれた緩衝ゴム27に、ダンパ受け部材25の端部当接し、更に橋脚2がX方向へ移動すると、塑性材21にX方向向きの荷重が作用し、図6に示すに、塑性変形部材21が塑性変形する。

【0025】油圧ダンパ30においては、本体部と、本体部31の両端部外へ延びる1対のロッドを有し、その作動ストロークが前記所定ストローよりやや長い既存の油圧ダンパが適用され、本体がブラケット29によりダンパ受け部材25に固れ、1対のロッド部33の先端部が、前記1対の材6の端面6aに連結部材34を介して固定的にれている。油圧ダンパ30の減衰係数αは、油圧30が所定ストロークA3作動する間、塑性変形1を塑性変形させずに、橋桁2のX方向の振動をに減衰できるように、後述するアクティブ制御手り制御されている。

【0026】図7に示すように、本体部31の内は、ピストン32が摺動自在に内嵌され、前記1ッド部33は、このピストン32から延び本体部外部へ突出している。本体部31内部のピストン仕切られた部分には、油路36により接続された1a、31bが形成されている。油路36には制ット60により駆動制御される電磁制御式の可変

基づいて、橋桁２のＸ方向の振動振幅Ａを求め、この振動振幅Ａに基づいて、電磁制御式の可変絞り弁３５の絞り量を制御して油圧ダンパ３０の減衰係数αを変化させるように構成してある。尚、制御ユニット６０と電磁制御式の可変絞り弁３５がアクティブ制御手段に相当する。

【００２７】橋桁２のＸ方向の振動振幅Ａをパラメータとして油圧ダンパ３０の減衰係数αは、図８の曲線ａとなるように、制御ユニット６０によりアクティブ制御されている。橋桁２の振動振幅Ａが０のとき減衰係数αは大きなα１に設定され、振動振幅Ａが０～Ａ１のとき減衰係数αは振動振幅Ａの増加に対して略比例的に減少し、振動振幅ＡがＡ１～Ａ２のとき減衰係数αは減衰性能を発揮する適切な略一定値に保持され、振動振幅ＡがＡ２以上（Ａ３を含む）のとき減衰係数αは振動振幅Ａの増加に対して略比例的に増加する。ここで、例えば、Ａ１＝５㎜、Ａ２＝２０～３０㎜、Ａ３＝３０～４０㎜である。

【００２８】即ち、前記アクティブ制御手段は、地震以外の振動で発生するような小さな振動振幅Ａ（Ａ＝０～Ａ１）の状態では、油圧ダンパ３０の減衰係数αを大きくすることで、油圧ダンパ３０をストッパ的に機能させ、地震時の振動で発生するような振動振幅Ａのうち所定値Ａ２以下の振動振幅Ａ（Ａ＝Ａ１～Ａ２）の状態では、油圧ダンパ３０の減衰係数αを減衰機能を発揮する適切な値に設定することで、橋桁２の振動を効果的に減衰させ、所定値Ａ２以上の振動振幅Ａの状態では油圧ダンパ３０の減衰係数αを大きくすることで、油圧ダンパ３０をストッパ的に機能させて、塑性変形部材２１に振動荷重が効果的に伝達されるように構成してある。

【００２９】図１、図２に示すように、橋桁２のＹ方向の振動を減衰させる１対の減衰機構４０の各々は、塑性変形部材４１と油圧ダンパ５０を有している。図７に示すように、油圧ダンパ５０は、本体部５１、ピストン５２、１対のロッド部５３、油室５１ａ、５１ｂ、油路５６、電磁制御式の可変絞り弁５５を有し、加速度センサ６２により橋桁２に作用するＹ方向の加速度を検出し、制御ユニット６０により前記加速度から求めた振動振幅に基づいて、電磁制御式の可変絞り弁５５の絞り量を制御し、油圧ダンパ５０の減衰係数αを前記と同様に図８に示す特性で変化させるように構成してある。尚、制御ユニット６０と電磁制御式の可変絞り弁５５がアクティブ制御手段に相当する。

【００３０】各減衰機構４０において、塑性変形部材４１は載置台４２の上面に固定され、塑性変形部材４１の上端部分には、ダンパ受け部材４５がＸ方向に移動自在に連結され、このダンパ受け部材４５に油圧ダンパ５０の本体部５１が固定されている。橋桁２の梁部材４の側先端部が夫々固定的に連結されている。尚、前記橋２０と同じ構造であるのでその他の説明を省略

【００３１】前記制振装置１０の作用・効果につ明する。車両走行時等の日常的な振動等、地震以動で発生するような小さな振動振幅Ａ（Ａ＝０～の状態では、アクティブ制御手段により制御されダンパ３０の減衰係数αが大きいため、橋桁２のに対応する２組の油圧ダンパ３０をストッパ的にせることができ、免震ゴム支承１２の水平方向の弱いことにより、橋桁２のＸ方向の小さな振動をることができる。

【００３２】また、地震時の振動で発生するよう振幅Ａのうち所定値Ａ２以下の振動振幅Ａ（Ａ＝Ａ２）の状態では、アクティブ制御手段により制た油圧ダンパ３０の減衰係数αが、減衰機能を発適切な値になり、塑性変形部材２１を塑性変形さに、油圧ダンパ３０及び免震ゴム支承１２により２のＸ方向の振動を効果的に減衰させることがで

【００３３】地震時の振動で発生するような振動のうち所定値Ａ２以上の振動振幅Ａの状態では、ィブ制御手段により制御された油圧ダンパ３０の数αが再び大きくなり、油圧ダンパ３０をストッ機能させて、塑性変形部材２１の塑性変形を促進とが可能になり、塑性変形部材２１の塑性変形を橋桁２のＸ方向の振動を減衰させることができる

【００３４】即ち、小振幅の振動から所定ストロ２までの振動を油圧ダンパ３０により減衰させ、トロークＡ２以上の大振幅の振動を塑性変形部材塑性変形を介して減衰させることができるため、の振動から大振幅の振動に亙って、橋脚８に対す２のＸ方向の振動を制振することが可能になる。故、作動ストロークが余り大きくない既存の油圧３０を有効活用できるため、油圧ダンパ３０の減を生かし、また、製作コスト的にも非常に有利なる。

【００３５】また、橋脚８と橋桁２の間に、橋桁平方向の振動を抑制する免震ゴム支承１２を設けて、油圧ダンパ３０及び塑性変形部材２１と協働橋脚８に対する橋桁２のＸ方向の振動を一層減衰ことができる。しかも、免震ゴム支承１２を設けて、所定値Ａ２以下の振動振幅Ａの振動後に、橋油圧ダンパ３０を初期位置へ復元させる復元作用れ、また、橋桁２の熱膨張や熱収縮に対応できる桁２の鉛直方向の振動も抑制できる。

【００３６】更に、橋桁２に作用するＸ方向の加検出する加速度センサ６１と、この加速度センサ検出された加速度から求めた橋桁２のＸ方向の振Ａに基づいて油圧ダンパ３０の減衰係数αを変化

係数αを、図8の曲線aとなるように制御するので、橋桁2のX方向の振動を効果的に減衰させることが可能になる。

【0037】具体的には、地震以外の振動で発生するような小さな振動振幅A(A=0~A1)の状態では、油圧ダンパ30の減衰係数αを大きくすることで、橋桁2を橋脚8に対して振動させないようにし、地震時の振動で発生するような振動振幅Aのうち所定値A2以下の振動振幅A(A=A1~A2)の状態では、油圧ダンパ30の減衰係数αを減衰機能を発揮する適切な値に設定することで、橋桁2の振動を効果的に減衰させ、地震時の振動で発生するような振動振幅Aのうち所定値A2以上の振動振幅Aの状態では、油圧ダンパ30の減衰係数αを大きくすることで、塑性変形部材21の塑性変形を促進し、ダンパ受け部材25と緩衝ゴム27の衝突によっても緩衝を図り、塑性変形部材21の塑性変形を介して橋桁2振動を効果的に減衰させることができる。

【0038】尚、橋桁2が橋脚8に対してY方向へ振動する際には、橋桁2の両端部に対応する4組の減衰機構40が前記減衰機構20と同様に機能して、前記と同様に橋桁2のY方向の振動を抑制する作用・効果を奏する。そして、本実施形態のように、橋脚8に対する橋桁2の水平方向の振動を制振する制振装置として、減衰機構20,40を有する制振装置10を適用すると、大型地震が発生した場合でも、橋桁2が橋脚8(又は橋台)から落下するという最悪の事態を確実に回避することが可能になる。

【0039】次に、別実施形態の制振装置について説明する。

第1別実施形態・・・図9参照

第1別実施形態の制振装置10Aは、前記制振装置10において橋脚8に対する橋桁2のY方向の振動を減衰させる減衰機構40の代わりに、減衰機構40Aを設けたものである。減衰機構40Aにおいて、塑性変形部材70は橋桁2の梁部材4の下面に固定され、塑性変形部材70の下端部分にダンパ受け部材71がX方向へのみ移動可能に連結され、ダンパ受け部材71の下面部に、油圧ダンパ72の本体部75がブラケット76で固定されている。

【0040】油圧ダンパ72は、本体部75と橋脚8側へ延びるロッド部73を有し、ロッド部73の先端部は、連結部材74を介して橋脚8の側面8aに固定的に連結されている。また、橋脚8の側面8aには、ダンパ受け部材71の端部が当接する緩衝ゴム27Aが取付けられている。この制振装置10Aの減衰機構40Aは、前記実施形態の減衰機構40と同様の作用・効果を奏する。

【0041】第2別実施形態・・・図10~図12参照

に本発明を適用した場合の例である。この制振装
Bにおいては、構造物84と基礎構造部82の間
数の免震ゴム支承12Bと、基礎構造部82に対
造物84のX方向の振動を減衰する2組の減衰機
と、基礎構造部82に対する構造物84のY方向
を減衰する2組の減衰機構81が設けられている

【0042】減衰機構80,81は、構造物84
を減衰する方向が異なるだけで同じ構造であるの
機構80について説明し、また、前記実施形態の
構20と略同様の構造であるので、減衰機構20
ものには同一符号を付して説明を省略する。図1
すように、各減衰機構80において、構造物84
部材83の下端部には、1対の補助部材85が下
出しており、これら1対の補助部材85に、油圧
30の1対のロッド部33の先端部が夫々固定的
されている。塑性変形部材21は基礎構造部82
されている。

【0043】制振装置10Bによれば、小振幅の
ら大振幅の振動に亘って、基礎構造部82に対す
物84の水平方向の振動を制振することが可能に
また、作動ストロークが余り大きくない既存の油
パ30を有効活用できるため、油圧ダンパ30の
能を生かし、また、製作コスト的にも非常に有利
になる。その他前記メイン実施形態と同様の作用
を奏する。

【0044】第3別実施形態・・・図13、図1
第3別実施形態の制振装置10Cは、ビルディン
7、88間に配設された複数の減衰機構90を有
ルディング87、88の水平方向の振動を制振す
である。各減衰機構90において、塑性変形部材
一方のビルディング87に固定された取付け部材
上端部に固定され、塑性変形部材91の上端部分
ンパ受け部材92がビルディング87、88の対
方向と直交する水平方向へ移動自在に連結されて

【0045】ダンパ受け部材92には、油圧ダン
の本体部94がブラケット95で固定され、油圧
99のロッド部96の先端部は、他方のビルディ
8の側面に連結部材97を介して固定的に連結さ
る。また、前記他方のビルディング88の側面に
ンパ受け部材92の端部が当接する緩衝ゴム93
けられている。この制振装置10Cにおいては、
ィング87,88に生じる異なる振動振幅を利用
ビルディング87,88の水平方向の振動を制振
のであり、前記実施形態と同様の作用・効果を奏

【0046】尚、前記実施形態及び第1~第3別
態において、塑性変形部材に、前記実施形態で開
ものに限らず、例えば、低降伏点鋼で構成したも
種々のものを適用可能である。また、アクティブ

になるように、油圧ダンパ30の減衰係数αを制御することも可能である。

【0047】加速度センサ61，62の代わりに、水平方向の速度を検出可能な速度センサ、又は、水平方向の変位を検出可能な変位センサ等の物理量検出センサを設け、この物理量検出センサで検出された信号から求めた振動振幅に基づいて、油圧ダンパの減衰係数を変化させるように構成してもよい。また、図示していないが、前記実施形態及び第1、第2別実施形態においては、免震ゴム支承12、12Bの代わりに、基礎構造部又は構造物との摩擦を介して振動を減衰させるすべり支承を設けてもよいし、このすべり支承を免震ゴム支承12、12Bとともに設けてもよい。

【0047】

【発明の効果】請求項1の構造物の制振装置によれば、構造物が基礎構造部に対して水平方向へ振動した場合、先ず、油圧ダンパが作動して構造物の水平方向の振動を減衰させる。即ち、油圧ダンパが所定ストローク以上作動しない振動においては、塑性変形部材を塑性変形させないで、油圧ダンパにより振動エネルギーを吸収し減衰させ、また油圧ダンパが所定ストローク分作動すると、次に、塑性変形部材が塑性変形して、振動エネルギーを吸収し構造物の水平方向の振動を減衰させる。即ち、小振幅の振動から大振幅の振動に亙って、基礎構造部に対する構造物の水平方向の振動を制振することが可能になる。それ故、作動ストロークが余り大きくない既存の油圧ダンパを有効活用できるため、油圧ダンパの減衰性能を生かした制振装置が得られ、製作コスト的にも非常に有利なものになる。

【0048】請求項2の構造物の制振装置によれば、請求項1と同様の効果を奏するが、基礎構造部と構造物の間に、構造物を鉛直方向に支持するとともに構造物の水平方向の振動を抑制する免震ゴム支承及び／又はすべり支承を設けたので、基礎構造部に対する構造物の水平方向の振動を一層減衰させることができる。特に、構造物の小振幅の振動においては、油圧ダンパを作動させなくても、免震ゴム支承により振動エネルギーを吸収して抑制できる。また、構造物の熱膨張や熱収縮に対応できる他、構造物の鉛直方向の振動も抑制することができる。しかも、免震ゴム支承を設ける場合には、構造物と油圧ダンパを初期位置へ復元させる復元作用が得られる。

【0049】請求項3の構造物の制振装置によれば、請求項1又は2と同様の効果を奏するが、構造物に作用する水平方向の変位に関連する物理量を検出する物理量検出手段と、この物理量検出手段で検出された信号から求めた振動振幅に基づいて油圧ダンパの減衰係数を変化させるアクティブ制御手段とを備えたので、構造物の振動振幅に基づいて、油圧ダンパの減衰係数を変化させるこ

【0050】請求項4の構造物の制振装置によれ求項3と同様の効果を奏するが、地震以外の振動するような小さな振幅の振動では、油圧ダンパの数を大きくすることで、油圧ダンパをストッパ的させ、構造物を基礎構造部に対して振動させないし、地震時の振動で発生するような振動振幅のう値以下の振動振幅の状態では、油圧ダンパの減衰適正な値に設定することで、油圧ダンパにより構振動を効果的に減衰させ、地震時の振動で発生すな振動振幅のうち所定値以上の振動振幅の状態で圧ダンパの減衰係数を大きくすることで、油圧ダストッパ的に機能させて、塑性変形部材の塑性変進することが可能になる。油圧ダンパが所定スト作動後には、塑性変形部材の塑性変形を介して構振動を減衰させることができる。

【0051】請求項5の構造物の制振装置によれ求項1～4の何れか1項と同様の効果を奏するが物が橋桁であるので、小振幅の振動から非常に大振動に亙って橋桁の水平方向の振動を制振することき、特に、大型地震が発生した場合でも、橋桁が（又は橋台）から落下するという最悪の事態を確避することが可能になる。

【図面の簡単な説明】

【図1】本発明の実施形態に係る制振装置を有す構造物のY方向から視た側面図である。

【図2】図1の橋梁構造物のX方向から視た側面る。

【図3】免震ゴム支承の部分断面斜視図である。

【図4】制振装置の減衰機構（初期状態）の作動である。

【図5】前記減衰機構（油圧ダンパ作動後）の作図である。

【図6】前記減衰機構（塑性変形部材の塑性変形作動説明図である。

【図7】油圧ダンパの断面図である。

【図8】振動振幅に対する油圧ダンパの減衰係数を示す図である。

【図9】第1別実施形態に係る制振装置の要部拡ある。

【図10】第2別実施形態に係る制振装置の平面る。

【図11】図10の制振装置の側面図である。

【図12】図11の制振装置の要部拡大図である

【図13】第3別実施形態に係る制振装置を配設ルディングの側面図である。

【図14】図13の制振装置の要部拡大図である

【符号の説明】

2 橋桁

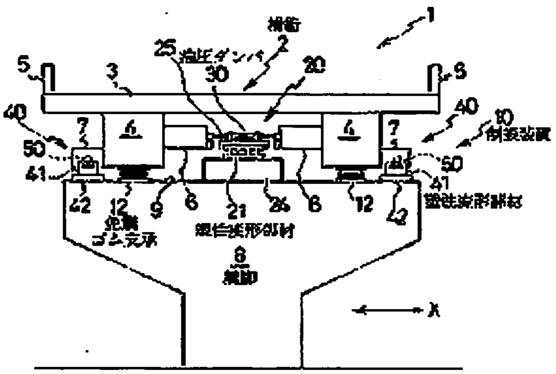
13

12，12B　　先端ゴム支承
21，41，70，91　塑性変形部材
30，50，72，99　油圧ダンパ
31，51，75，94　本体部

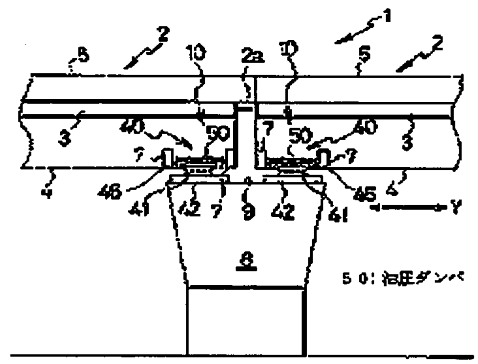
14

＊33，53，73，96　ロッド部
35，55　　　電磁制御式可変絞り弁
60　　　　　制御ユニット
＊　61，62　　　加速度センサ（物理量検出手段

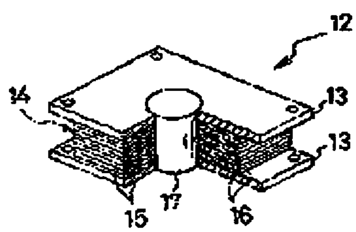
【図1】



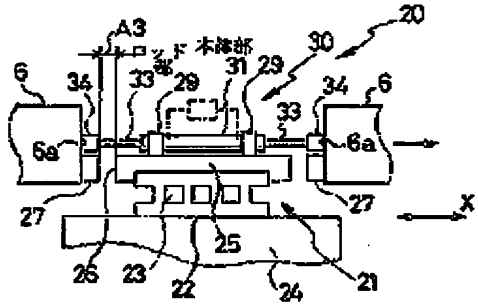
【図2】



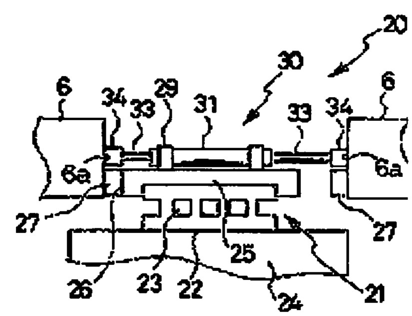
【図3】



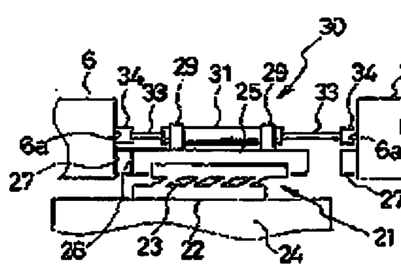
【図4】



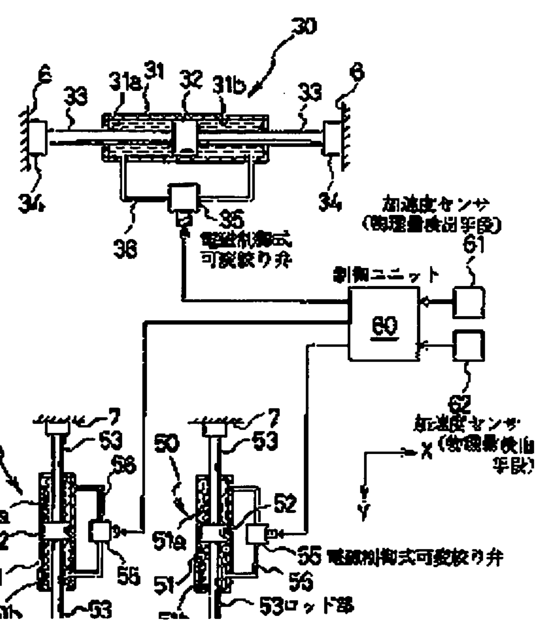
【図5】



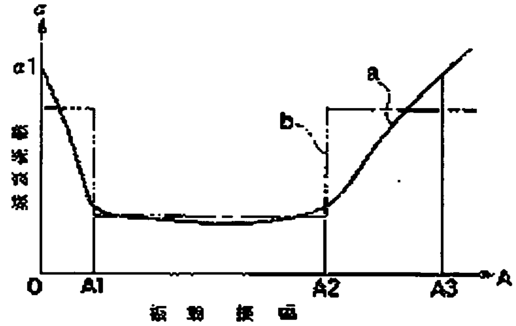
【図6】



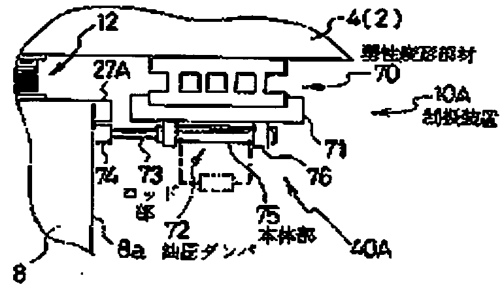
【図7】



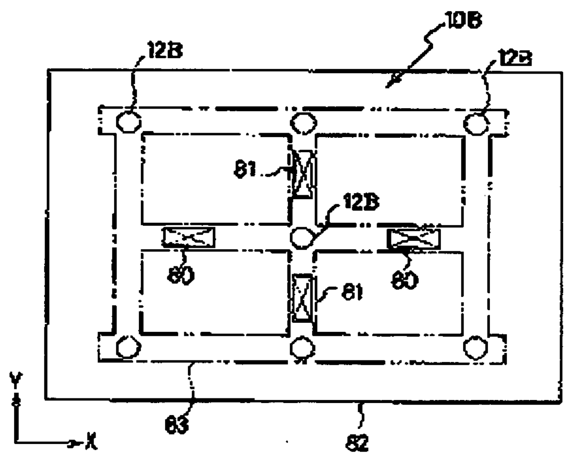
【図８】



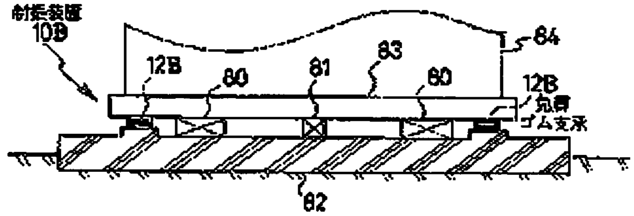
【図９】



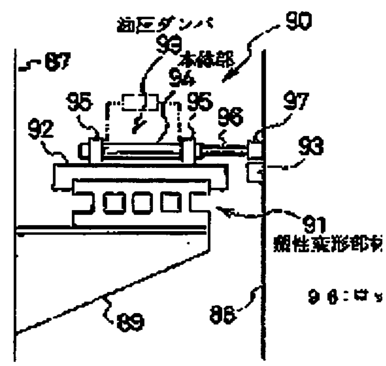
【図１０】



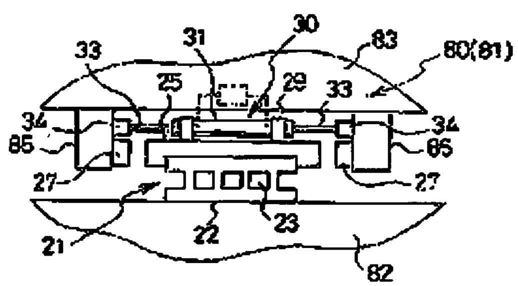
【図１１】



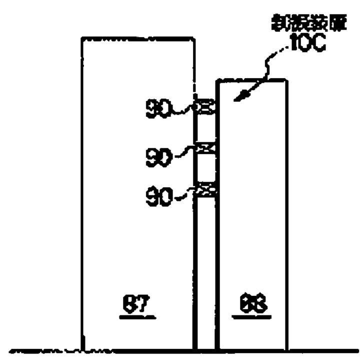
【図１４】



【図１２】



【図１３】



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